JPRS-UEQ-93-006
12 August 1993

JPRS Report

Science & Technology

Central Eurasia: Engineering & Equipment

Science & Technology
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Theoretical Principles of Rigid-Body Wave Gyro

937F0171A Moscow IZVESTIYA ROSSIYSKOY AKADEMII NAUK: MEKHANIKA TVERDOGO TELA in Russian No 3, May-Jun 93 pp 6-19

[Article by V.F. Zhuravlev, Moscow; UDC 531.383]

[Abstract] The physical principles of the rigid wave gyro (VTG) which are valid for all free elastic systems with axial symmetry are considered using the example of a thin elastic circular ring. In so doing, attention is focused on the plane kinematic precession of standing waves (referred to as the precessing waves), spatial precession of standing waves, and standing wave precession in fractional-connectivity systems. A general classification of perturbations is studied, and the main concepts of standing wave control are analyzed. The underlying principle of rigid wave gyro—the wave inertia—is formulated mathematically, and an experiment in which the wave inertia phenomenon was observed is described for the first time. The wave inertia observations reported in published sources are reviewed. The conclusion is drawn that elastic wave inertia may be used in actual systems for developing functional gyroscopic instruments. Figures 1; tables 1; references 4: 2 Russian, 2 Western.

Oscillation Stability of Rigid Gyro

937F0171B Moscow IZVESTIYA ROSSIYSKOY AKADEMII NAUK: MEKHANIKA TVERDOGO TELA in Russian No 3, May-Jun 93 pp 20-32

[Article by V.Ye. Yurin, Moscow; UDC 531.383]

[Abstract] The functioning of a rigid wave gyro is examined as a single electromechanical system. To this end, oscillations of a free perfect vibrator are considered as a superposition of two standing waves which are orthogonal to each other with respect to both their spatial position and time phase, and the oscillation equations of an imperfect electrostatically controlled vibrator are derived. The rigid wave gyro control problem is formulated as maintaining oscillations in the form of standing waves. For simplicity's sake, the vibrator is modeled by a ring whose density depends on the turning angle and is generally represented by a Fourier series and whose energy dissipation is described by the Kelvin-Voight model. The gyro vibrator oscillations are electrostatically controlled by 16 discrete and one ring electrodes. The function of signal processing in the oscillation control system is examined and a control algorithm is developed. The issue of electromechanical oscillations in the rigid wave gyro is addressed. It is shown that the requisite gyro operation mode has the necessary conditions of stability, asymptotic stability, and stability under constantly applied perturbations relative to the requisite phase variables. The findings confirm that the oscillation control system makes it possible to accomplish the task of maintaining stable operating conditions of the gyro which are close to oscillations of a free vibrator without the conservative and dissipative effects. Figures 1; references 6.

On Self-Sustained Oscillations of Vertical Gyro With Radial Correction

937F0171C Moscow IZVESTIYA ROSSIYSKOY AKADEMII NAUK: MEKHANIKA TVERDOGO TELA in Russian No 3, May-Jun 93 pp 32-36

[Article by S.A. Agafonov, Moscow; UDC 531.383]

[Abstract] The development of self-sustained oscillations in a vertical gyro with radial correction is considered, and the gyro motion equations are derived. The solutions of the equations are examined from the viewpoint of ascertaining the self-sustained vibration conditions; an analysis shows that this requires that two roots of the characteristic equation of disturbed gyro motion intersect the imaginary axis at a nonzero rate and the solution of the motion equation be either asymptotically stable or unstable. The behavior of the roots of the characteristic equation in the neighborhood of $n=e$ and the stability of the motion equation solution at $n=e$ are investigated. The mathematical procedure of designing the free-running operating condition is examined in detail. The asymptotic stability of the free-running condition is demonstrated, and the self-sustained oscillation amplitude and period are approximately determined. The conclusion is drawn that this free-running condition developing at ne belongs to the central manifold embedded in a four-dimensional phase space which contains the solution of motion equation of the radially corrected vertical gyro. The manifold is two-dimensional which corresponds to the number of imaginary roots of the characteristic equation. A numerical example is cited for illustration. References 4.

On Possibility of Utilizing High-T_c Superconductivity Phenomena in Gyros

937F0171D Moscow IZVESTIYA ROSSIYSKOY AKADEMII NAUK: MEKHANIKA TVERDOGO TELA in Russian No 3, May-Jun 93 pp 37-41

[Article by V.V. Filatov, Moscow; UDC 531.383]

[Abstract] The electric and magnetic properties of superconductors (SP) which open up unique prospects for advancement in gyroscopy prompted a study of the possibility of using the phenomena of high-T_c superconductivity (VTSP) in gyros, particularly at nitrogen temperatures (77K). The issue of increasing the cryogenic gyro accuracy is largely determined by the accuracy of the pickups which transmit data from the gyro sensor. The superconducting quantum interference device (SQUID) which is the magnetic flux detector with an exceptional sensitivity is the most precise sensor. For example, the superconducting ring resistance oscillates when the magnetic flux through it changes by a single quantum. Since SQUID operation in the field of the

gyro's magnetic suspension calls for careful shielding from both the suspension's own fields and external magnetic fields, including the geomagnetic, the physical principles of high-T_c superconducting ceramic shields and their difference from conventional shields are examined. Attention is focused on an experimental investigation of high-T_c superconducting ceramic shields made in domestic equipment aimed at ascertaining the possibility of using them in gyro sensors (Ch.E.). To this end, 100 mm long cylindrical ceramics with a 24 mm outside diameter, a 2 mm thick wall, and a 3 mm thick bottom made from high-T_c superconducting yttrium ceramics with additions of silver and from bismuth ceramics are studied. Ag-doping increases the critical parameters and makes it possible to improve the shield quality. The ceramic preparation procedure is outlined, and the testing technique is described. Extended tests of the high-T_c superconducting ceramic shields conducted for 24 h at a stable external magnetic field at one-half of the critical level did not reveal any magnetic field penetration. The findings make it possible to draw the conclusion that high-T_c superconducting ceramic shields can be used in gyros, accelerometers, gradient meters, and other devices where the magnetic fields do not exceed the critical level for the specific ceramics, i.e., close to 10 Oe. On the other hand, such HTSC ceramics are not suitable for cryogenic gyros with a magnetic rotor suspension whose magnetic field reaches hundreds of oersteds. Figures 3; references 12: 5 Russian, 7 Western.

Dependence of Electrostatic Gyro's Angular Velocity on Ambient Temperature

937F0171E Moscow IZVESTIYA ROSSIYSKOY AKADEMII NAUK: MEKHANIKA TVERDOGO TELA in Russian No 3, May-Jun 93 pp 42-49

[Article by S.Zh. Karipbayev, B.Ye. Landau, Yu.G. Martynenko, V.V. Podalkov, Moscow and St. Petersburg; UDC 531.383]

[Abstract] The effect of the ambient temperature on the angular velocity of an electrostatically suspended gyro is discussed. To this end, the temperature distribution in the gyro rotor is examined, and a spherical rotor of an electrostatically suspended gyro spinning inside an evacuated spherical cavity is considered assuming that the nonsteady temperature field inside the rotor is centrally symmetric, i.e., its isothermal surfaces are concentric with the rotor surfaces, in which case the temperature meets the conditions of the heat conduction equation. The boundary condition on the rotor edge is derived, and it is shown that the formulated problem is nonlinear due to this condition. The rotor deformations caused by its heating nonuniformity are determined, and the rotor spinning equations for a variable moment of inertia are derived. The radial unbalance is the principal factor affecting the angular velocity stability of the gyro in a vacuum. For illustration, numerical estimates are made using a recursive formula. The findings show that periodic ambient temperature fluctuations lead to fluctuations of the gyro's angular velocity. A comparison of the theoretical and experimental data reveals an approximately two-fold discrepancy which is attributed to the fact that in addition to the ambient temperature fluctuations and the resulting temperature-induced rotor deformations, other factors also affect the angular velocity stability. The authors are grateful to A.I. Kobrin for constructive discussions. Figures 3; references 3: 2 Russian, 1 Western.

Nonlinear Phenomena in Rotating Circular Ring Dynamics

937F0171F Moscow IZVESTIYA ROSSIYSKOY AKADEMII NAUK: MEKHANIKA TVERDOGO TELA in Russian No 3, May-Jun 93 pp 50-59

[Article by N.Ye. Yegarmin, Moscow; UDC 531.383]

[Abstract] Oscillations of a rotating thin elastic ring are discussed, and the nonlinear expressions of the ring's potential and kinetic energy are derived assuming that the ring material properties are linear and are subject to Hooke's law while the nonlinearity is primarily due to purely geometrical factors. It is shown that under such conditions, the ring oscillations can be regarded as random and are not standing waves. The equations of the rotating inelastic ring's nonlinear dynamics are derived on the basis of Hamilton's principle. The equations of slow variables are examined by the method of many scales, and the wave pattern is described in a Cartesian system of coordinates in order to clarify the oscillation wave pattern evolution of the gyro case, i.e., the rigid wave gyro vibrator. For clarity's sake, the wave pattern is described in canonical variables in the form of a superposition of standing waves which are orthogonal in the configurational space and quadratic in the time domain. A number of nonlinear effects is established in the wave pattern evolution, particularly the wave pattern precession relative to the vibrator even when the base is not spinning; to wit, if the wave pattern is represented by standing waves traveling in the opposite directions, the total wave pattern always remains stationary since the traveling wave amplitudes and corrections for nonlinearity are equal. If, however, the vibrator oscillations are not a standing wave, the traveling wave amplitudes are not equal to each other and, consequently, the nonlinearity corrections are not equal too; the difference results in the general wave pattern precession. References 6: 5 Russian, 1 Western.

Regular Rigid Body Precessions Under Effect of Velocity-Wise Linear Forces

937F0171G Moscow IZVESTIYA ROSSIYSKOY AKADEMII NAUK: MEKHANIKA TVERDOGO TELA in Russian No 3, May-Jun 93 pp 60-67

[Article by I.A. Galiullin, Moscow; UDC 531.383]

[Abstract] Regular precessions of a rigid body under the effect of forces which are linear with respect to velocities are discussed, and a rigid body with an arbitrary fixed

point whose motion is described by variations in Euler's angles which determine the position of the body-axes rectangular system of coordinates relative to the Cartesian axes of the inertial system is considered. The rigid body motion is a regular precession with an axis of proper rotation and an axis of precession whereby the directions are selected to ensure that the corresponding constant projections of angular velocities are positive. The body moves under the effect of gyroscopic forces which are linear functions of generalized velocities corresponding to Euler's angles. The necessary and sufficient conditions of the null potential of the field of forces are derived. G. Grioli's problem of motion of a rigid body each of whose points is under the effect of a force calculated as the vector product of this point's velocity by the same constant vector is considered, and the generalized forces are expressed by a system of equations with arbitrary coefficients. The existence of regular precession in a field of forces with the principal moment of inertia determined by the above equations is analyzed in the case where this vector is produced by a linear transform from another constant vector along which the precession axis is assumed to be directed. References 9: 4 Russian, 5 Western.

On Oscillatory Phenomenon in Two Mechanics Problems

937F0171H Moscow IZVESTIYA ROSSIYSKOY AKADEMII NAUK: MEKHANIKA TVERDOGO TELA in Russian No 3, May-Jun 93 pp 68-72

[Article by I.V. Skorobogatykh, Moscow; UDC 531.383]

[Abstract] Torsional vibrations of a rotating spherically symmetric elastic body with a perfectly rigid insert are considered in the case where the symmetry centers of both bodies coincide and rotate in the inertial space at a constant angular velocity, and the elastic displacements are equal to zero on the common boundary. The elastic body material is isotropic and uniform and follows the linear theory of small deformations. The task of studying the torsional vibrations of the elastic body ignoring other types of oscillations is formulated. It is shown that since the body moves at a constant angular velocity, the equations of motion have an energy integral, hence all natural frequencies are purely imaginary. The equations of motion show that in a first approximation, torsional vibration waves precessing at given rates and frequencies exist. Vibrations of a rigid body with elastic constraints are considered in order to reveal an analogy between the above phenomenon and vibrations of a perfectly rigid body in a gimbal mount with elasticity. A comparison demonstrates that the equations of motion of both systems describe similar processes, i.e., elastic vibration wave precession of an elastic body and instantaneous torsional vibration axis precession of a rigid body in a gimbal mount with elasticity. The above phenomena may be used to develop inertial navigation sensors, such as angle data transmitters and angular velocity meters. Figures 1; references 4.

Unified Notation of Equations of Motion of Heavy Rigid Body on Horizontal Support

937F0171I Moscow IZVESTIYA ROSSIYSKOY AKADEMII NAUK: MEKHANIKA TVERDOGO TELA in Russian No 3, May-Jun 93 pp 73-80

[Article by A.P. Ivanov, Moscow; UDC 531.384]

[Abstract] The problem of deriving a standard notation of the equations of motion of a heavy rigid body on a horizontal support is formulated, and in so doing, the origin of coordinates of the inertial system is placed on the supporting plane and the feasible motion domain is defined as $Z \geq 0$. The body is bounded by the convex surface without ribs and may have contact with the plane at one of its point. The purpose of the unified notation is to make it suitable for describing all three types of motion, *viz.*, unrestricted, restricted, and impulsive, and for describing the support phase, bounces on the horizontal surface, and shocks against the supporting surface. The method of continuous representation is used as the basis for deriving the notation. The particular cases of smooth support and Coulomb's friction are examined in detail. The findings show that the phase variables preserve continuity during the entire motion thus ensuring the effectiveness of the analytical and numerical research methods. Figures 1; references 6: 5 Russian, 1 Western.

Analytical Investigation of Dynamics Equations of Low-Flying Satellite by Computer Algebra Methods

937F0171J Moscow IZVESTIYA ROSSIYSKOY AKADEMII NAUK: MEKHANIKA TVERDOGO TELA in Russian No 3, May-Jun 93 pp 89-94

[Article by A.F. Bragazin, V.V. Leonov, V.M. Rudenko, I.P. Shmyglevskiy, Moscow; UDC 681.3.062]

[Abstract] The orbital motion of a satellite assumed to be a material point in the Earth's field with perturbations determined by the gravitational inhomogeneities is considered. To this end, an inertial geocentric equatorial Cartesian system of coordinates wherein the satellite state at a random moment is determined naturally by the position and velocity vectors is introduced, and its equations of motion are derived. A quaternion of the transition from the existing basis to the orbital basis with an origin at the satellite (ISZ) center of mass is introduced as the new variables for determining the orbital spatial attitude and satellite position in orbit. The averaging method is used to integrate the principal satellite motion equations. The system of equations is examined with the help of the asymptotic integration algorithm employing the Lie group theory methods. The task of processing the cumbersome notations is solved with the help of the REDUCE computer language using the Polymex-symbol routines resulting in a system of averaged equations in a fourth approximation. The findings make it possible to formulate a totally new approach to

developing the satellite position computation algorithms which lend themselves to numerical analysis. References 7: 5 Russian, 2 Western.

Plane Resonant Motions of Viscoelastic Body in Elliptical Orbit

937F0171K Moscow IZVESTIYA ROSSIYSKOY AKADEMII NAUK: MEKHANIKA TVERDOGO TELA in Russian No 3, May-Jun 93 pp 95-102

[Article by B.S. Bardin, A.P. Markeyev, Moscow; UDC 531.5]

[Abstract] Plane resonant motions of a viscoelastic body in an elliptical orbit is considered. To this end, the motion of a large space structure modeled by a viscoelastic body—a thin viscoelastic homogeneous nonstretching circular ring with a material point of random mass attached to it—relative the center of mass in a central Newtonian gravitational field in an elliptical orbit is considered in the case where the ring motion as a whole and the deformation of its individual elements occur in the orbital plane of the center of mass. The angular velocity of the ring rotation is assumed to be small compared to its lowest free elastic vibration frequency; the task is studied in the framework of the linear theory of elasticity. The dissipative forces are assumed to be small compared to the elastic forces. The equations of motion are derived, the problem of free plane flexural vibrations of the elastic ring with the material point is solved, and expressions are derived for the elastic displacement. Steady-state oscillation modes and rotations under a resonance are determined assuming that the ring is a perfectly rigid body while the orbit of its center of mass is circular, i.e., the equations of motion are those of a simple pendulum. The steady-state condition stability is investigated. An analysis demonstrates that steady-state vibration modes are asymptotically stable near the resonance under certain conditions. Figures 6; references 7.

Vibration Damping of System Containing Unbalanced Rotor

937F0171L Moscow IZVESTIYA ROSSIYSKOY AKADEMII NAUK: MEKHANIKA TVERDOGO TELA in Russian No 3, May-Jun 93 pp 110-118

[Article by L.D. Akulenko, Moscow; UDC 531.36]

[Abstract] A plane rotational-vibrational system is examined assuming that the load carrying structure, i.e., the housing, may move plane-parallel within the limits permitted by the shock absorbing devices which link it to a fixed base. The system contains an unbalanced rotor which spins around a mobile axis braced to the housing and excites the load carrying body vibrations. The system may be exposed to external (gravitational) forces. The problem of damping the initial (natural) and forced body vibrations with the help of controlling the shock absorbing device characteristics is formulated. The equations of motion are derived in nondimensional variables by introducing time and length units which are associated with the housing vibration period and amplitude. The vibration damping problem is addressed by selecting the controlling functions, and the parametric (multiplicative) controlling actions are assumed to be piecewise smooth. The housing vibration damping with the resonant and nonresonant rotor modes is considered, and the variable stiffness and viscosity coefficients under both conditions are used as the manipulated variable for minimizing the amplitude of horizontal and vertical vibrations over a fixed time interval. The possibility of local optimum stiffness control for damping resonant excitation and quenching the natural rotor vibrations is established. It is noted that the housing stabilization near the resonant rotor spinning area is complicated and calls for imposing extreme constraints on vibrations due to the equivalent linear dissipation and for effectively damping vibrations outside the resonance area. Figures 1; references 10: 8 Russian, 2 Western.

Optomathematical Model of Polarized Infrared Images of Objects. Part 1: Simulation Theory

937F0168B St. Petersburg IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 36 No 1, Jan-Feb 93 pp 92-98

[Article by V.M. Tymkul, M.I. Ananich, Novosibirsk Engineering Institute of Geodesy, Aerial Photography, and Mapping; UDC 681.7.015.2.535.518]

[Abstract] The importance of infrared imagery simulation in the theory and practice of optoelectronic infrared imager design and the ambiguity of the problem of determining the shape of the object surface inside its outline on the basis of conventional infrared images prompted a study of the theory of polarized infrared image simulation whereby the images depend functionally on the object shape inside its contour. The theoretical premises of simulating polarized infrared images of complex-shaped objects are presented. To this end, an entity with an arbitrary shape is considered in a Cartesian system of coordinates assuming that the entity is observed from a point where the sensor of the infrared imager detector is located. The method of constructing the polarized infrared images of objects using the Stokes vector-parameter of thermal radiation is discussed in detail, and the method of constructing the polarized infrared images of objects using the thermal polarization degree and azimuth is described. The formulae which serve as an optical-mathematical model of polarized infrared images of radiating objects are derived. Another expression is proposed in the cases where one must simulate the polarized images by the polarization degree distribution. Figures 2; references 3.

Determining Design Parameters of Encoded Discs of Optoelectronic Digital Angle Encoders Under Effect of Vibratory Loads

937F0168A St. Petersburg IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 36 No 1, Jan-Feb 93 pp 54-61

[Article by I.V. Meskin, G.V. Kirchin, Precision Mechanics and Optics Institute, St. Petersburg; UDC 681.325.519.863]

[Abstract] The design and operating principle of optoelectronic digital angle encoders with a digital readout is described, and a schematic diagram of such device is cited. The effect of induced vibrations developing during the optoelectronic angle encoder operation due to the kinematic excitation of the base directed along the disc axis and the resulting undesirable disc contact with the slit diaphragm or disc fracture due to the low glass resistance to cyclic stresses are discussed, and a disc model with its discrete design diagram for optimizing the design variables are suggested. An approximate method is proposed for determining these design parameters under vibratory loads with variable frequency and vibration acceleration amplitude. To ensure that the proposed design diagram is equivalent to the disc design, the disc's rigidity and inertial parameters are made consistent with those of the design diagram. The specific measures taken for ensuring this equivalence, e.g., proper selection of the cross section height of the rod element at which its edge sag under its own weight is equal to the disc edge sag, are outlined, and the dependence of the natural vibration frequency on the rod element cross section height is plotted. It is assumed that the natural vibration frequencies may fall within the working band of induced vibrations, resulting in a resonance; consequently, the resonance conditions are examined for optimizing the design. The method makes it possible to ensure the induced structure vibration amplitudes specified beforehand. It is noted that another method of solving the problem exists whereby the resonance amplitude and frequency are found for a disc with a given thickness. Figures 3; tables 1; references 6.

Stored-Program Control of Robotic Product Assembly From Elastic Elements

937F0159F St. Petersburg IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 35 No 1-2, Mar 92 pp 114-118

[Article by I.F. Kuzmitskiy, N.A. Selchenok, I.K. Asmykovich, Belarussian Technological Institute; UDC 62-503.5]

[Abstract] The large number of manual operations characterizing car tire assembly which led to the development of a robotic complex (RTK) for this purpose necessitated, in turn, the development of a more advanced control algorithm. A final radial pneumatic tire assembly line which is an integral component of the robotic complex is examined; the assembly line is based on the aggregate modular principle which consists of four assembly modules. The operation and design principle of each module are described in detail, and a mathematical model of the process is developed. An algorithm for controlling the product assembly from elastic components is cited and the requirements imposed on the transient processes of the synthesized system are formulated. In the case of an emergency shutdown, rejects, and completion of production, the system terminates operation; if one of the modules shuts down, processing of elements continues in other modules until the modular cycles are completed. The software includes interactive facilities for displaying data on screen, diagnostic tests, and routines for identifying the parameters and calculating the control actions. The algorithm can be realized in the mass-produced SM-4 microcomputers and output microcontrollers. Figures 1; references 4.

Azimut' Spectropolarimeter for Remote Sensing of Natural Objects

937F0159E St. Petersburg IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 35 No 1-2, Mar 92 pp 100-106

[Article by A.A. Buznikov, P.S. Yeliseyev, G.A. Lakhtanov, St. Petersburg Electrical Engineering Institute imeni V.I. Ulyanov (Lenin); UDC 535.568.1]

[Abstract] The insufficient luminous flux dynamic range of existing polarimeters for remote sensing of the natural resources (30-50 dB) and the need for analog-to-digital conversion of the measured radiation data for subsequent computer processing prompted the development of the Azimut spectropolarimeter which realizes digital automatic gain control based on using path-distributed resistive attenuators controlled by numerical codes and a microprocessor-based data control and processing system. The design of the polarimeter consisting of two modules—optomechanical and electronic—is outlined and its operating principle is described. A block diagram of the polarimeter is cited and timing charts of the measurement signal are plotted. The Azimut operates within a 400-750 nm band while a narrower band can be separated by four automatically replaced interference filters with a transmission band of $\leq$10 nm; its total measurement cycle duration is 6 s and and its field of view angle is 2-6° at a dynamic range of 60 dB. The power demand is $\leq$80 W and DC power supply system draws 27 V. The mass and overall dimensions of the optomechanical module of 170x170x380 mm and 7.8 kg and those of the optical module—480x160x480 mm and 12.6 kg. The instrument can be used for determining the characteristics of a broad range of objects in the environment. Figures 2; references 5.

Fiber Optic Loop-Type Interferometer-Based Logic Gates

937F0159D St. Petersburg IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 35 No 1-2, Mar 92 pp 95-99

[Article by V.Yu. Rakovskiy, A.S. Shcherbakov, St. Petersburg State Engineering University; UDC 681.325.65:535]

[Abstract] A fiber optic device with the effect of phase self-modulation in a nonlinear loop interferometer is investigated, and attention is focused on the possibility of full optical realization of such logic operations as EXCLUSIVE OR or AND which serve as the basis for developing optical adders and are sufficient for carrying out an arbitrary arithmetic-logic computer system function. The mechanism of Kerr's nonlinearity in unimodal quartz optical fibers characterized by a femtosecond response time is used, making it possible to attain the limit of speed in processing digital information streams. A schematic diagram of the fiber optic loop interferometer on the basis of Sagnac's interferometer and the signal from a photodetector installed in the loop interferometer's output channel with a slow increase in the input optical signal power are cited, and the output current curves are plotted. The information processing capabilities of the device at high data stream densities are assessed. The conclusion is drawn that the development of workable gates on the basis of fiber optic loop interferometers may become virtually impossible at an input information stream's relative pulse duration of less that 10. Yet the possibility of using pico- and subpicosecond pulse durations will enable us to reach a response speed of up to 10^{12} bit/s even given $Q \geq 10$. Figures 3; references 2: 1 Russian, 1 Western.

Outlook for Improving Principal Characteristics of Infrared Imager Detector

937F0159C St. Petersburg IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 35 No 1-2, Mar 92 pp 77-81

[Article by B.Ye. Smolyanskiy (deceased), L.B. Smolyanskiy, State Optics Institute imeni S.I. Vavilov, St. Petersburg; UDC 621.391.82:621.383]

[Abstract] The difficulties with developing multisensor photodetectors for infrared imaging, the relative advantages of scanning techniques, and the lack of systematic studies of various sensor distribution configurations in detectors prompted an investigation into the prospect of improving the main characteristics of infrared imager detectors. To this end, the principal parameters of such detectors are examined, and the field of view, resolution, sensitivity threshold, and direction-finding properties are considered in detail. Various patterns of element distribution in a detector array are cited and their advantages and shortcomings are summarized. Based on the comparison, the potential of each multielement detector array is assessed. The features of partially scanned systems are outlined; this design simplifies system development by reducing the requisite scope of the axis of sight deviation. The development of partially scanned detectors lays the groundwork for designing devices without any moving parts on the basis of electron-optic, magnetic-optic, and other phenomena. Figures 4; references 6: 5 Russian, 1 Western.

On Possibility of Realizing Pulse Signal Superresolution in Optoelectronic Systems

937F0159B St. Petersburg IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 35 No 1-2, Mar 92 pp 66-69

[Article by Ye.K. Kuznetsov, V.G. Chernenko, State Optics Institute imeni S.I. Vavilov, St. Petersburg; UDC 621.391.2:621.384.32]

[Abstract] The problems of ensuring the requisite signal parameter measurement accuracy at a minimum possible photodetector (FPU) sensor scanning frequency which arises in designing digital optoelectronic systems (OES), especially for closely positioned sources which lead to the appearance of interfering pulses at the photodetector output, and the outlook for using superresolution at a signal:noise ratio of 5-10 are discussed. An iterative algorithm for measuring the parameters of interfering pulses in a one-dimensional case which has an elevated resolution combined with a relatively high response speed is considered. The algorithm is based on the local estimation method and is suitable for evaluating signals represented by only 2-10 samples at the pulse half-width. The resolution reliability function (FNR) which describes the probability of signal resolution in a pulse train as a function of the SNR and the maximum tolerated relative error is introduced for describing the statistical results. The findings demonstrate that the iterative superresolution algorithm for one-dimensional signals makes it possible to increase the effective optoelectronic system resolution by 1.5-3 times compared to Rayleigh criterion-based methods. Figures 3; references 3: 2 Russian, 1 Western.

Motion Trajectory Optimization of Two-Axis Servo Turntable During Gyro Testing

937F0159A St. Petersburg IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 35 No 1-2, Mar 92 pp 37-45

[Article by V.V. Voronov, V.A. Matveyev, Moscow State Engineering University imeni N.E. Bauman; UDC 629.7.05]

[Abstract] The procedures and underlying principles of gyro and gyro system testing are outlined and it is noted that one of the main goals of gyro testing is to determine the natural precession rate (SSP). A study of gyro testing in a two-axis servo turntable (SNP) where the natural precession rate is determined by the reaction to the application of a unit *g*-load from the gravity force with a change in the gyro attitude relative to the *g*-vector direction is presented. To this end, a single degree of freedom gyro with two mutually perpendicular rotation axes is tested, and nine components of the natural precession rate are measured. A natural precession rate model is derived, and the initial gyro setting optimization is studied. A computer routine compiled for selecting the optimum input action is outlined and for illustration, the optimum trajectory is calculated for assessing the natural precession rate model components. A topographic method of searching for the optimum trajectory by plots of functions without using computer time is proposed. A computational experiment confirms the advantages of using the optimum trajectory over any other servo turntable motion. A considerable increase in the observability matrix determinant over the optimum trajectory makes it possible to tolerate a much higher instrument noise level (i.e., to relax the accuracy requirements) or decrease the number of precession rate observation points without any loss of estimation accuracy. Figures 4; references 6: 3 Russian, 3 Western.

Nuclear Power Plants and Feasible Alternatives

937F0172A Moscow VESTNIK ROSSIYSKOY AKADEMII NAUK in Russian Vol 63 No 6, Jun 93 pp 498-502

[Article by I.I. Novikov, G.N. Kruzhilin, Ye.P. Annyev, Metallurgy Institute imeni A.A. Baykov at Russia's Academy of Sciences, Nuclear Power Development Safety Issues Institute at Russia's Academy of Sciences, and Scientific Research Institute of Nuclear power Plants at Russia's Energy Ministry]

[Abstract] The discussion of nuclear power plant safety issues which began in *Vestnik RAN* No. 9, 1992 and No. 3, 1993 is continued. The state of affairs in the industry and the causes of accidents are reviewed, and the development outlook is assessed. The conclusion is drawn that there is no sound scientific or technical reason, nor has there been any, for the nuclear phobia which ensued after the Chernobyl catastrophe and that stagnation in the nuclear power industry must be overcome. The inexpedience of using natural gas for generating electric power is analyzed from the economic and technical viewpoints, and advances in nuclear reactor and power plant safety, both at home and abroad, are summarized. Safety issues of pressurized water reactors and containment structures are examined, and achievements in improving the safety of high-power pressure-tube RBMK reactors are noted. The feasibility of upgrading obsolete VVER water-cooled water-moderated power reactors by shrinking the core by eliminating peripheral fuel assemblies and thus lowering the neutron flux is discussed. The prospects of new electrochemical power generating facilities which are environmentally clean are reviewed and their advantages are demonstrated. It is speculated that a pilot electrochemical power plant which will eventually replace both nuclear and fossil fuel power plants can be built in the next 10-15 years. References 7: 2 Russian, 5 Western.

Numerical Investigation of Radioactive Aerosol Spread and Precipitation in Containment Structure During Nuclear Power Plant Accident

937F0162A Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 64 No 3, Mar 93 pp 363-370

[Article by A.I. Porshnev, V.P. Reshetin, Radiation Physico-Chemical Problems Institute at the Belarussian Academy of Sciences, Minsk; UDC 621.039.58]

[Abstract] The aerosol spread in the condensing atmosphere of the containment structure under typical severe nuclear power plant accident conditions is investigated in order to determine the feasibility of the filtering system selection and terrain contamination prediction in the case of containment structure leaks. To this end, a point model—the NAUA computer routine—based on the assumption of uniform aerosol composition throughout the containment structure is examined; the package is a component of the STCP software package. Other assumptions used in the model and the specific physical processes incorporated in the model are described. The aerosol transport processes in a confined volume are simulated with the help of volume sources and particle drains. The aerosol particle behavior algorithm is proposed, and the behavior of the total suspended aerosol mass and total containment losses, the behavior of the mean aerosol particle radius, and the behavior of the particle size distribution function are plotted. It is noted that in examining the aerosol particle behavior, the test function method may serve as an efficient numerical analysis algorithm which makes it possible to switch from the integrodifferential aerosol equation to a system of several differential equations for such trimming parameters as the mean radius, variance, and mean countable particle concentration. Examples of test calculations are cited for illustration. Figures 3; references 8: 1 Russian, 7 Western.

Systematic VVER-440 Coolant Temperature Measurement Errors: Radiative Thermocouple Heating

937F0167A Moscow IZMERITELNAYA TEKHNIKA in Russian No 5, May 93 pp 51-53

[Article by A.S. Timonin; UDC 621.039]

[Abstract] The systematic error resulting from the thermocouple's hot junction heating under irradiation with neutrons and γ-radiation despite the fact that the junctions are encased in sealed working tubes—the temperature monitoring channels—is examined. The specific problem of thermocouple hot junction heating in the VVER-440 water-moderated water-cooled power reactor used at many nuclear power plants is addressed, and the importance of analyzing the systematic measurement error is emphasized. This error depends both on the ionizing radiation flux at the thermocouple location and on its design characteristics. To assess the error, the problem of the temperature field distribution along the radius of an infinitely long two-layered cylinder is solved for TKhA-2076 thermocouples. The systematic error was determined directly in the second generating unit of the Rovno nuclear power plant using various thermocouple designs. The effect of hot junction encapsulation on the systematic error in different thermocouples is compared. Figures 3; references 5.

Critical Conditions in Cooling Ponds of Nuclear Power Plants With Water-Cooled Water-Moderated Power Reactors

937F0169A Moscow ELEKTRICHESKIYE STANTSII in Russian No 6, Jun 93 pp 27-29

[Article by Ye.I. Ignatenko, Yu.I. Savchuk, V.I. Saprykin, Russian Nuclear Power Concern and Kurchatov Institute Regional Scientific Center; UDC [621.311.25:621.039]:621.039.68-621.039.58]

[Abstract] Concern that safety criteria may be violated under certain emergency conditions in the spent nuclear fuel cooling storage ponds (BV) at nuclear power plants with a storage cell spacing designed to ensure reliable subcriticality of the fresh fuel assembly clusters with a design enrichment level in pure (boron-free) cold water prompted an examination of the principal premises contained in relevant regulations which have already been implemented (unnecessarily, in the authors' opinion) at the Kalinin nuclear power plant. To this end, the parameters of an infinite triangular net for storing fuel assemblies with a varying enrichment and burnable absorber rods are designed for the VVER-400 and VVER-1000 water-cooled water moderated power reactors (VVER); the number of fuel elements (tvel) in the assembly, the external fuel element diameter, the fuel element spacing in the assembly and their width across flats, the fuel assembly cladding thickness, the mean fuel element density in the cooling storage pond net, etc., are summarized. The three events which may occur as a result of possible human errors leading to a boric acid concentration decrease, pond cooling failure, water heating and boiling, and eventual criticality according to the critics are discussed, and the six conditions which must be met under such scenario are refuted one by one. The conclusion is drawn that at present, there is no need to change the existing storage cooling pond design and fuel storage practices. Tables 1; references 3: 2 Russian, 1 Western.

Investigation of Fuel Combustion Completeness in Combustion Chambers With Film Vaporizers

937F0165A Minsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY I ENERGETICHESKIKH OBYEDINENIY SNG in Russian No 3-4, Mar-Apr 93 pp 82-86

[Article by A.S. Dobrovolskiy, E.L. Kitanin, S.I. Shelukho, R.Z. Garipov, St. Petersburg State Engineering University; UDC 621.438.03]

[Abstract] The effect of the combustion chamber (KS) reliability and efficiency on the small-size gas turbine engine (MGTD) operating indicators is discussed, and methods of increasing the fuel combustion completeness in such combustion chambers are considered. Attention is given to efforts to separate the fuel vaporization, carburation, and combustion proper and especially to enhance combustion using film vaporizer elements (IE) in which the first two of the three stages occur. A mushroom-type vaporizer which is believed to be the most promising from the viewpoint of uniform fuel distribution along the combustion chamber perimeter and ignition reliability is examined in detail and its schematic diagram is cited. Due to the difficulty of delineating the processes inside the chamber, a model is proposed whereby the fuel combustion completeness is expressed as a function of the fuel-air mixture stay duration in the combustion chamber by the time necessary for vaporization, carburation, and combustion. The role of the stabilizer flanging angle in ensuring reliable ignition is examined in an experiment using a full-scale model of a standard combustion chamber. The theoretical and experimental dependence of the combustion completeness on the flanging angle and distance from the vaporizer outlet is plotted. The findings show that air intake close to the stabilizer greatly worsens the combustion indicators. The consistency of experimental and theoretical data is noted. Figures 3; references 6.

On Cylindrical Precession Stability of Viscoelastic Body Oscillating Along Symmetry Axis

937F0177A Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 57 No 2, Mar-Apr 93 pp 57-66

[Article by Ye.V. Sinitsyn, Moscow; UDC (531.36+629.19): 534]

[Abstract] The relative motion of a homogeneous isotropic viscoelastic dynamically symmetric body traveling in a central Newtonian field of forces is considered in a body axes system of coordinates with an origin at the center of mass assuming that the center of mass moves in a fixed circular orbit. It is also assumed that the body material satisfies the Kelvin-Voight model of the linear theory of viscoelasticity at a constant time-independent Poisson ratio. In contrast to previous formulations, flexural vibrations which do not contribute to the linear part of the inertia tensor are not taken into account, and the stability of the partial solution of equations of motion which correspond to a uniform body rotation around the symmetry axis orthogonal to the circular orbit plane is analyzed. The system of equations of motion is reduced to singularly disturbed equations whose asymptotic solution is sought by the method of boundary functions. The stability is examined within the entire range of parameters using Kamenkov's criterion with the help of the reduction principle of the theory of denumerable systems of differential equations. The conclusion is drawn that the nondisturbed motion which corresponds to uniform rotation is asymptotically stable within a certain parameter range. The consistency of the stability conditions is checked on a computer. The author is grateful to A.P. Markeyev for interest in the study and discussions. Figures 1; references 15.

On Stability of Relative Elastic Satellite Equilibria With Respect to Part of Variables

937F0177B Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 57 No 2, Mar-Apr 93 pp 67-76

[Article by L.Yu. Anapolskiy, S.V. Chaykin, Irkutsk; UDC 531.36]

[Abstract] The motion of an elastic satellite modeled by a rigid body with an elastic arbitrary isotropic link attached to it in a central Newtonian field of forces is considered in a rectangular Cartesian system of coordinates in a limited formulation whereby the satellite's center of mass travels in a circular Kepler orbit around an attracting center at a constant angular velocity; it is also assumed that the perturbing deformation vector is represented by an infinite series in terms of the unknown orthogonal eigenmodes of its free vibrations, the central inertial ellipsoid is triaxial in the nondeformed state, and the potential energy of gravitational attraction is determined by a known equation. The relative equilibria positions of the elastic satellite, i.e., its quiescent states relative to the orbital system of coordinates (OSK), are examined; if the elastic link is deformed in the relative equilibrium position, it is referred to as nontrivial. An attempt is made to demonstrate the sufficient conditions of relative equilibria position stability with respect to the satellite velocity and position coordinates on the basis of the stability theorem allowing for the effect of elastic coordinates which determine elastic deformation. The conclusion is drawn that if the relative satellite equilibrium position exists, its central axes plotted for this equilibrium are collinear with the axes of the orbital system of coordinates. References 11.

On Rigid Body Motion in Particle Flow

937F0177C Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 57 No 2, Mar-Apr 93 pp 77-81

[Article by A.A. Burov, A.V. Karapetyan, Moscow; UDC 531.36]

[Abstract] The problem of rigid body motion in a gas flow is considered in a formulation where the gas consists of identical noninteracting particles flying at a constant velocity in a constant stationary absolute space while the particles interact with the body absolutely inelastically, i.e., after the collision, the particle velocity relative to the body is equal to zero. It is assumed that the body surface is convex—if the approach flow velocity greatly exceeds the product of the representative value of the body's angular velocity by the characteristic distance from the body to a fixed point, the body's equations of motion can be expressed through the tensor of the body inertia relative to the fixed origin of coordinates whose axes are directed along the principal axes of inertia of the inertia tensor. The analysis is carried out from the viewpoint of Newton's study of forces and moments during a rigid body interaction with a medium. The substantially nonconservative nature of the problem is stated, and it is noted that the body dynamics can be described by a system of Hamilton's equations. The applicability conditions of this phenomenon are examined. In particular, the cases of centrally symmetric and axisymmetric body surface are addressed. The existence of additional first integrals of equations of motion due to the Hamiltonian structure is discussed, and the specific cases where such integrals exist are indicated. It is shown that even in the simple mechanical model used, peculiar dynamic properties can be found while the issue of the effect of the terms omitted in the expression for moments for simplicity's sake warrants a separate investigation. The stability of steady-state motions of the system is examined. References 4: 3 Russian, 1 Western.

Eddy Flows Induced by Shock Wave Interaction With Reduced-Density Finite-Length Thin Channels

937F0166H Moscow IZVESTIYA ROSSIYSKOY AKADEMII NAUK: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 3, Mar-Apr 93 pp 149-153

[Article by V.I. Artemyev, V.I. Bergelson, S.A. Medvedyuk, I.V. Nemchinov, T.I. Orlova, V.A. Rybakov, V.M. Khazins, Moscow; UDC 533.6.011.72]

[Abstract] The shock wave interaction with thin reduced-density channels and the resulting global gas dynamic flow reordering accompanied by a vortical motion with intense matter mixing encompassing the entire precursor volume are discussed. The dynamics of this eddy flow induced by a thin reduced-density channel in the precursor developing in front of shock waves propagating in the channel after propagation, up to the nondisturbed flow recovery stage, are investigated by numerically solving the problem of steady-state piston in a cylindrical tube filled with a perfect nonviscous non-heat-conducting gas. The phenomenon is examined experimentally in an explosion tube unit where the heated rarefied channel in the buffer gas naturally developed under the effect of thermal radiation emitted by the strong shock wave's impact upon a thin finite-length wire stretched along the tube. The consistency of experimental and theoretical data attests to the suitability of the numerical analysis in the framework of Euler's equations. The predicted induced turbulization and shock wave front collapse phenomenon may also occur under a high-velocity impact of large meteorites on the surface of the Earth or other planets with natural fissures and cracks which play the role of rarefaction channels. It is noted that similar eddy phenomena occur in supersonic flows about a blunted body with a thin rarefied finite-length channel or with a larger-scale heated area creased by a heat source in front of it. Figures 2; references 8: 7 Russian, 1 Western.

Solution of Thermoelasticity Equations in Rotating Cylinder Cross Section by Singular Perturbation Method

937F0177D Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 57 No 2, Mar-Apr 93 pp 124-132

[Article by M.I. Letavin, N.I. Shestakov, Cherepovets; UDC 593.3]

[Abstract] The cross-sectional temperature distribution in a cylinder spinning at a constant angular velocity is discussed, and an attempt is made to derive asymptotic formulae for determining the temperature-induced stress developing in the cylinder interacting with the environment by the radiant and convective heat transfer law in the framework of the nonconsistent theory of thermoelasticity in a (ρ, φ) cylindrical system of coordinates assuming that all functions are 2π-periodic with respect to the independent variable φ. A formal asymptotic expansion of the temperature function is constructed and substantiated, and asymptotic formulae of stresses are derived for the perturbation expressed through Predvoditelev's criterion, making it possible to take into account the heat transfer variability throughout the cylinder perimeter, identify the qualitative nature of stress distribution in the boundary area and the remainder of the cylinder, and demonstrate that the stressed state is due to the nonsymmetric part of the temperature field. For illustration, thermal stresses in a continuous casting machine roller are examined. The conclusion is drawn that thermoelastic stresses do not reach the maximum safe limits, so the temperature field nonuniformity cannot be responsible for the roller failure. Figures 3; references 8.

On Pursuit-Evasion Game of Two Controlled Objects With Restricted Maneuverability

937F0178A Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 57 No 3, May-Jun 93 pp 23-33

[Article by K.A. Zemskov, A.G. Pashkov, Moscow; UDC 62-50]

[Abstract] The pursuit and evasion game of two controlled objects with a restricted maneuverability moving on a plane at constant velocities whereby the objects' equations of motion and constraints on their control actions are defined by the same correlations as in the well-known game of two cars is considered. The problem of plotting an optimum pursuer position strategy which enables him to approach the evading object at a minimum distance at a random time is formulated, and the domains of pursuer and evader reachability are examined. To simplify the problem, the system of coordinates is modified by placing its origin to the pursuer's initial approach point. The systems of equations of motion are integrated. The domains of initial evader positions for which the resulting optimum strategy leads to eventual point capture during a specified time are determined with the help of a computer analysis. The findings are discussed from the viewpoint of their relevance to the referenced sources. Figures 7; references 8: 2 Russian, 6 Western.

Study of Plane Stratified Flow Around Object

937F0178B Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 57 No 3, May-Jun 93 pp 41-49

[Article by A.M. Ter-Krikorov, Dolgoprudnyy; UDC 532.5]

[Abstract] A plane steady-state flow of a perfect heavy incompressible liquid with an arbitrary stable stratification and a free boundary around a body located inside the flow or on a horizontal bottom is considered in a system of coordinates with an origin on the bottom assuming that the total particle energy in the nonperturbed flow is sufficient to ensure that the particle is capable of rising in the gravitational field from an equilibrium level to the half-height of the obstacle whereby the obstacle cannot block the flow. The equation of motion is linearized, and the solution is represented in an integral form. Tikhonov's and Samarskiy's theorem of the uniqueness of the external Dirichlet problem solution in a plane case is extended to the nonsymmetric conditions. The problem of flow is solved using the methods of the potential theory, and dipole

approximations are examined at a vanishing emissivity. References 6: 5 Russian, 1 Western.

Surface Acoustic Waves Near Shock Absorbing Layer-Covered Bodies

937F0178C Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 57 No 3, May-Jun 93 pp 163-167

[Article by N.I. Gvozdovskaya, A.I. Plis, Moscow; UDC 532.5:534.1]

[Abstract] Waves developing and propagating near the surface of bodies covered with a compressible shock absorbing layer in a space filled with a perfect compressible liquid are considered in the case where the waves attenuate rapidly with the distance from the surface. The nonclassical boundary condition which simulates the shock absorbing layer is formulated. Surface waves developing in a planar waveguide formed by two rigid walls covered with a shock absorbing layer and the eigenmodes in a plane waveguide with shock absorbing walls are considered. It is shown that as the waveguide width increases, its walls cease affecting each other, so its eigenmodes turn into a surface wave. Surface waves inside and outside a cylindrical waveguide with shock absorbing walls are examined in a similar fashion, and surface waves in the cylindrical layer between the coaxial cylinders covered with shock absorbing layers are investigated. The findings show that waves localized within a certain layer whose thickness depends on the coat's mechanical properties may propagate near the body. The authors are grateful to Yu.D. Chashechkin and S.V. Nesterov for discussions. Figures 4; references 5.

Steady-State Contracted Arc Discharge-Based Plasma Generator for Plasma Charged Particle Sources

937F0170A Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 3, May-Jun 93 pp 144-148

[Article by A.V. Vizir, A.G. Nikolayev, Ye.M. Oks, P.M. Shchanin, G.Yu. Yushkov, High Current Electronics Institute at the Siberian Department of Russia's Academy of Sciences, Tomsk; UDC 621.384]

[Abstract] Uses of contracted arc discharges with a cold cathode in ion and electron plasma sources with a periodic pulse action and the discharge current and stable glow duration limitations are discussed. The operating principle, design, and characteristics of a plasma generator based on a steady-state contracted arc discharge with a 2-10 A current are studied, and the electrode system assembled in water-cooled cermet housings is described. The discharge is ignited by a steady-state weak-current Penning discharge, thus simplifying the power supply circuit and making it possible reliably to fire the discharge if it is accidentally quenched. The voltage-current curves of the contracted discharge, the radial plasma concentration distribution, and the voltage-current characteristic of the steady-state ion source on the basis of the plasma generator are plotted. Measurements show that at a 20 cm distance from the contraction channel opening, the plasma concentration is equal to 10^{10} ion/cm^3 and the electron temperature reaches 10 eV. Likely applications of the device, e.g., for generating ion beams, are discussed. The above generator was used as an ion source for producing Ar, Xe, N_2, and O_2 ions with a $\geq$200 mA current at a beam cross section of 200 cm^2. The findings make it possible to produce not only ion but also electron beams with a current close to the discharge current using steady-state contracted arc. Figures 4; references 8.

Sfera-2 Superconducting Magnetic System

937F0170B Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 3, May-Jun 93 pp 181-188

[Article by G.L. Berezin, I.A. Kiryenin, Ye.S. Trifonov, High Temperatures Institute at Russia's Academy of Sciences, Moscow; UDC 621.318.43:537.312.62]

[Abstract] Practical implementations of inductive energy integrators with a shielding system made as two spherical superconducting windings with an opposite current direction—the so-called "sphere in the sphere" system—which effectively suppresses the magnetic leakage fields are discussed and attempts to develop the next phase of the superconducting magnetic system—the Sfera-2 with improved parameters—are reported. The new system's parameters (with a peculiar electromagnetic interaction between the windings) call for developing a power structure which ensures the serviceability of the system as a whole. A schematic diagram of the Sfera-2 system and its conductors is cited, and the design specifications of the "sphere in the sphere" system and the parameters of the Sfera-2 system obtained by analyzing the manufacturing, testing, and experimental data are summarized. Tests of a screened superconducting system with a 1.28 m diameter and 1.52 m height carried out at the High Temperatures Institute at Russia's Academy of Sciences under the scientific supervision of Prof. V.V. Andrianov (who passed away shortly thereafter) made it possible to attain an energy storage capacity of 2.55 MJ. The tests confirm the need for active winding preburning at a current of $\geq$1,000 A. The tests generally support the prospects of using complex superconducting "sphere in the sphere" systems in large-scale devices for effectively suppressing leakage fields. Figures 3; tables 2; references 5.

Compact Electromagnet for Frozen Polarized Proton Target

937F0170C Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 3, May-Jun 93 pp 189-193

[Article by O.A. Grachev, V.P. Damshin, L.T. Zakamskaya, A.P. Meshchanin, S.B. Nurushev, V.L. Rykov, High Energy Physics Institute, Serpukhov; UDC 621.318.3:621.039.6(045)]

[Abstract] The advantages of polarized targets with a frozen spin over targets with continuous dynamic nuclei polarization pumping, particularly the possibility of attaining large usable solid angles for recording the reaction products and placing protective counters around the target, are discussed, and a simple design of a compact electromagnet which combines the functions of the two magnets usually employed for this purpose—one with a strong field and a small aperture to ensure the polarization pumping conditions and one with a weak field and a large aperture to hold polarization in the frozen state—is described. The polarized frozen target magnet is developed for the Proza unit in the U-70 accelerator at the High Energy Physics Institute in Serpukhov. A schematic diagram of the compact electromagnet and a block diagram of the regulated power supply system for it are cited, and design values of the magnetic field deviation from the rated value of 2.5 T in the cross section relative to the magnet center with triangular lateral shims are plotted. The magnet has spreadable poles and can be used with a 400 mm long target with a 20 mm diameter. At a 74 mm pole gap, a working target field reaches 2.5 T at a 1.5×10^{-4} irregularity. After dynamic polarization pumping at a working temperature, the poles are spread by 25 mm thus ensuring the secondary particle ejection within a 0.4 sr solid angle at which point the field in the gap drops to 0.46 T. Polarization can be reversed rather quickly (in less than 10 min) using a special rotary base. The power supply system is also capable of reversing the target polarization by reversing the magnet current in 20 s, but this calls for an additional independent magnetic field of 2.5 kG and other conditions, and is not currently used. The authors are grateful to the management of the High Energy Physics Institute and Joint Institute for Nuclear Research and to A.I. Ivanenko, V.A. Kormilitsyn, Yu.A. Ilin, and Ye.K. Yermolayeva for assistance. Figures 3; references 3.

Synchronizing Two-Stage Hybrid Particulate Accelerator

937F0170D Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 3, May-Jun 93 pp 194-196

[Article by M.G. Musayev, State Scientific Research Energy Institute imeni G.M. Krzhizhanovskiy, Moscow; UDC 629.7.036.74]

[Abstract] The limitations of light gas accelerators (LGU) as the first stage of plasma accelerators, especially for use as hyperaccelerators, and the advantages of hybrid accelerators—a combination of light gas accelerators and electrodynamic plasma accelerators—are discussed. A schematic diagram of a hybrid two-stage accelerator with a synchronization system is cited and its design and operating principle are outlined. A coaxial high-voltage accelerator with a plasma piston matched with a light gas accelerator serves as the second acceleration stage. The two-stage accelerator operates under strong electromagnetic interference and is synchronized with the help of a control pulse generator on the basis of miniature photocells and optical waveguides. Protection is ensured by applying light pulses from the accelerator channel to the shielded space where the recording electronic equipment is located. In addition, the optical waveguides protect the system from electromagnetic pickup and high voltage currents. Figures 2; references 3.

Industrial Ion Source

937F0170E Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 3, May-Jun 93 pp 215-218

[Article by B.I. Zhuravlev, V.V. Prilepskiy, V.S. Gorlatov, Rubezhansk Department of the Dnepropetrovsk Chemical Engineering Institute; UDC 537.24+621.384.5]

[Abstract] The difficulty of forming rectangular beams in self-contained ion sources for ion-beam material treatment in a vacuum and the resulting drop in the technical and economic indicators prompted the development of axially nonsymmetric discharge system, e.g., employing a self-sustained contracted discharge with a cold hollow cathode and a two-stage series bulk electron breeding circuit as the ion generator. A schematic diagram of the ion source system is cited, and the voltage-current curves of ion discharges at various electromagnetic system current levels and the dependence of the ion beam current on the accelerating voltage at various discharge currents are plotted. The source can be used with argon, oxygen, nitrogen, and other gases and is capable of generating a 5 keV beam with a current of up to 0.1 A and a 40x80 mm^2 cross section. The ion current density is flat across the larger side of the rectangular beam within 10%. Figures 3; references 4.

New Possibilities of Using Carbon as Heater Material

937F0170F Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 3, May-Jun 93 pp 224-227

[Article by L.A. Ashkinazi, All-Russian Electrical Engineering Institute, Moscow; UDC 621.385]

[Abstract] The advantages of carbon-carbon composites for use as cathode unit heaters which make it possible to radically increase the heater shape stability at high temperatures are discussed, and the procedure of fabricating such composite heaters is outlined. Attention is focused on the design and performance capabilities of high-temperature heaters operating at temperatures of up to 2,500°C in a vacuum or inert gas. The composite heaters may have a complex shape and variable cross section and are capable of self-insulating during heating. Their resistance can be adjusted when they are heated in the air due to oxidation. This makes it possible to avoid sorting the cathodes into categories and does not develop inhomogeneities in the heater and local overheating.

Measurements show for some carbon fiber fabrics without and with pyrolysis, the resistance variation is 2-10%/h and 0.3-3%/h, respectively. The procedure of developing a heat insulating layer on the resistor and heater surface by heating the samples in the air is described. References 9.

Numerical Investigation of Steady-State Separation Supersonic Flow About Three-Dimensional Carrying Systems

937F0166G Moscow IZVESTIYA ROSSIYSKOY AKADEMII NAUK: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 3, Mar-Apr 93 pp 142-148

[Article by S.S. Graskin, Moscow; UDC 533.6 011.5]

[Abstract] The use of numerical methods of solving linear problems and their shortcomings at moderate and large angles of incidence which call for developing new approaches for taking into account the nonlinear phenomena are discussed, and a numerical method is proposed for investigating the supersonic flow about complex three-dimensional configurations. The proposed method is an extension of, and improvement over, known approaches widely used to solve similar problems in subsonic aerodynamics. The problem of a random system of thin carrying surfaces moving in a perfect gas flow at a constant supersonic velocity is considered, and the task of determining the field of perturbed velocities, vortical structures, and aerodynamic loads affecting this system at moderate and small angles of incidence in a flow is formulated. The above problem is solved allowing for the nonlinearities due to large disturbances and flow separation from the sharp leading and trailing edges. To this end, the carrying surfaces are substituted by a family of longitudinal and transverse bound vortex elements, and the free vortex surface from the leading and trailing edges is replaced with a family of free vortex lines coinciding with the lines of flow. An iterative numerical algorithm is proposed for determining the intensities of the vortex segments and coefficients of the total aerodynamic forces and moments. For illustration, the aerodynamic characteristics of thin airfoils of various shape in a flow are examined using the proposed algorithm. The analyses are carried out on a YeS-1066 computer. Figures 5; references 10: 9 Russian, 1 Western.

Measuring Fog Parameters Behind Shock Wave in Foam

937F0166F Moscow IZVESTIYA ROSSIYSKOY AKADEMII NAUK: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 3, Mar-Apr 93 pp 134-141

[Article by A.B. Britan, I.N. Zinovik, V.A. Levin, Moscow; UDC 532.694:529.5+533.6.011.72]

[Abstract] Shock wave propagation in a dry polyhedral foam with $\simeq$ 1 cm cells is investigated experimentally in a shock tube within a wave Mach number range of M-1.1-1.4. In so doing, the interaction process is captured on film, making it possible to establish that the initial foam deformation is due to the air movement in the cells toward the shock. The developed foam film surface shifts and turns the cell around by a distance commensurate with the cell channel length due to the windage effect. Subsequent film and channel breakdown is accompanied by tiny flares from smaller droplets; the droplet mixing with the gas flow leads to the development of fog which spreads throughout the entire flow field with a certain delay. It is noted that in contrast to wet foam which withstands a threefold compression, dry foam breaks down easily under shock waves with $M>1.1$, while the modal dimension of the resulting fog corresponds to the drop diameter of the monodisperse flow. At a mean foam density of 4 kg/m, the effective gas model predicts a 15% pressure rise in the relaxation zone, yet this is not observed experimentally, probably due to the low concentration of drops by volume. Both the model drop size and drop concentration by volume are found by the spectral transmission method. Figures 5; references 15: 11 Russian, 4 Western.

Hydroelastic Interaction of Immersing Bottom With Liquid

937F0166E Moscow IZVESTIYA ROSSIYSKOY AKADEMII NAUK: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 3, Mar-Apr 93 pp 118-125

[Article by A.D. Vasin, Moscow; UDC 532.582.2: 534.121.1]

[Abstract] The shortcomings of earlier studies of the effect of the elasticity of structures immersing into a liquid on the hydrodynamic forces which employ the quasisteady-state hydroelastic analysis method and do not take into account the elastic vibration velocity and acceleration and membrane forces prompted the development of a mathematical model of the immersing bottom's hydroelastic interaction with the liquid which would more fully take into account such factors as the elastic vibration velocity and acceleration, membrane forces, initial sag, and support mobility. To this end, a planar problem of immersion into a liquid at a constant velocity of a bottom with a deadrise angle of $\beta \leq 30^\circ$ consisting of elastic plates which may have an initial sag and a nonrectilinear shape whereby the lower plate edge is rigidly restrained by the keel while the upper edge is connected to the stringer, is considered. The immersion process ceases when the wetted surface reaches the upper support of the elastic plate. In this formulation, the elastic plates are cylindrically bent. An elastic strip beam with a unit width is cut from the plate and its vibration equation is derived. The equation is solved by the Bubnov-Galerkin method. The velocity potential is assumed to be null on the free boundary outside the wetted bottom part, and the wetted width of the elastic bottom is found. The hydrodynamic pressure on the bottom surface is determined, and the system of basis parameters which serve as the diagnostic variables for the hydroelastic bottom interaction with the liquid is

derived. It is shown that at late immersion stages, the elastic vibration velocity decreases and acceleration becomes negative, thus leading to an increase in the hydrodynamic pressure and a slower decrease in the elastic vibration velocity. Figures 5; references 12: 11 Russian, 1 Western.

Asymptotic Theory of Vortex Breakdown

937F0166D Moscow IZVESTIYA ROSSIYSKOY AKADEMII NAUK: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 3, Mar-Apr 93 pp 78-90

[Article by V.V. Sychev, Moscow; UDC 532.527: 532.516]

[Abstract] The phenomenon of viscous vortex line breakdown is examined at Reynolds numbers approaching infinity based on an asymptotic analysis of a system of Navier-Stokes equations for steady-state axisymmetric flows of an incompressible liquid. To this end, a thin rectilinear vortex filament in a uniform swirled flow of a viscous incompressible liquid is considered assuming that the flow is steady-state and has axial symmetry, and that circulation is constant in the swirled flow outside the vortex line. An attempt is made to establish the vortex breakdown criteria and describe the flow structure in general and in the immediate proximity to the breakdown point in particular. It is noted that the vortex collapses when the longitudinal and azimuthal velocity vector components inside the vortex line are on the same order of magnitude. The external flow area surrounding the recirculation flow zone is studied assuming that the flow as a whole is described by the solution which is a generalized form of Hill's solution for a spherical vortex in the case where a Bernoulli constant discontinuity exists on the zero line of flow. The study shows that the vortex breaks down in two phases—a flow deceleration due to the external flow swirling causing the Pitot pressure on the symmetry axis of the viscous core to vanish, and further deceleration as a result of which the flow velocity on the symmetry axis vanishes. The resulting surface encompasses the slow return current area. Available experimental data and the outcome of numerical solution of the Navier-Stokes system of equations attest that the flow near the closure point is transient. This phenomenon probably extends to the return current area where the flow velocity is low. The slow recirculation flow area is bounded by an ellipsoid surface. Figures 2; references 31: 11 Russian, 20 Western.

Numerical Investigation of Flows in Mixed Spatial Boundary Layers of Prolate Spheroid in Flow With Angles of Incidence

937F0166C Moscow IZVESTIYA ROSSIYSKOY AKADEMII NAUK: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 3, Mar-Apr 93 pp 69-77

[Article by Yu.N. Karpeyev, St. Petersburg; UDC 532.526.74]

[Abstract] Two cases of mixed flow in spatial boundary layers of prolate ellipsoids with a ratio of 6 in a flow about it at an angle of incidence of 10 and 5° are numerically investigated using the finite difference method; in the former case, we have a "prescribed" laminar-to-turbulent transition in a narrow flow region located at a distance from the nose tip equal to 20% of the body length while in the latter—a natural transition in an extended area. Equations from *Mekhanika zhidkosti i gaza* No. 6, 1990 are used for the numerical flow analysis in the laminar area of the mixed spatial boundary layer; for the turbulent and transition conditions, the equations are derived from the moment of momentum and mass conservation equations for an arbitrary continuum denoted in a tensor notation in a normal system of coordinates. The system of equations of turbulent and transition spatial boundary layer is reduced to an easier form after a tensor analysis, a transition to physical components, simplifications which follow from the boundary layer theory estimates, elimination of pressure with the help of potential flow equations, other manipulations aimed at simplifying the boundary conditions, and reduction of variables to a nondimensional form. The turbulent condition is initiated by a 2-cm-wide annular roughness strip at a 48 cm distance from the nose cone. The flow turbulization during the transition leads to a flow reordering and eliminates the spatial separation which otherwise occurs in the region under study in a laminar flow. Secondary flows also decrease greatly. The findings demonstrate that turbulent mixing significantly weakens the spatial effects, shifts the spatial separation zones downstream, and reduces their size. The principle of superposition of viscous and turbulent stresses and a "mixing path" model generalized for the case of three measurements are used in constructing the closure equation. Figures 6; references 9: 3 Russian, 6 Western.

Turbulent Boundary Layer Evolution Under Successive Effect of Shock Wave and Expansion Fan

937F0166B Moscow IZVESTIYA ROSSIYSKOY AKADEMII NAUK: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 3, Mar-Apr 93 pp 61-68

[Article by M.A. Goldenfeld, Novosibirsk; UDC 532.526.4]

[Abstract] The boundary layer evolution under high positive and negative pressure gradients in the flow is discussed, and an extreme case of such flow, the boundary layer flow through a shock wave or expansion fan, is considered; in particular, the layer evolution under the successive effect of these two phenomena is investigated. To this end, the symmetric boundary layer is modeled by a thin-walled hollow tube with a skirt consisting of a combination of conical surfaces successively realizing the compression and rarefaction angles installed on it. To measure the static pressure, 24 drains are made in the tube. The experiment is carried out in the T-313 supersonic tunnel made by the Theoretical

and Applied Mechanics Institute at the Siberian Department of Russia's Academy of Sciences at Mach numbers of 3 and 4 and unit Reynolds numbers of 3.5×10^7 and 5.6×10^7 m^{-1}, respectively, and a 270-278K temperature. The findings show that the shock wave preceding the expansion fan substantially weakens the effect of the Reynolds number on the boundary layer characteristics behind the expansion fan, eliminates the relaminarization, and shortens the length of the boundary layer relaxation zone. The results of the study also demonstrate that the successive action of the shock wave and expansion fan cannot be treated as a simple superposition of two isolated effects with opposite pressure gradients since the process is largely nonlinear and depends on a broad range of diagnostic variables, e.g., the boundary layer's spectral and energy characteristics. Figures 6; references 13: 12 Russian, 1 Western.

Nonlinear Waves in Viscous Compressible Liquid With Relaxation

937F0166A Moscow IZVESTIYA ROSSIYSKOY AKADEMII NAUK: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 3, Mar-Apr 93 pp 31-35

[Article by S.V. Korsunskiy, Kiev; UDC 532.516:534.2]

[Abstract] Propagation and stability of nonlinear waves in a viscous incompressible liquid with relaxation is studied. The relaxation properties of the liquid are taken into account by introducing a time relationship between the stress tensor and deformation rate tensor in the rheological state equation, resulting in a phase shift between the stress and deformation rate of the moving liquid and, consequently, dispersion and additional losses of the flow's mechanical energy relative to the dissipative losses due to viscosity and heat conduction. A medium in which acoustic wave propagation does not upset the thermodynamic equilibrium condition is considered. The energy equation is derived assuming that the medium is subject to the state equation of perfect gas. The one-dimensional finite-amplitude wave evolution in a relaxing medium is investigated allowing for the viscosity and heat conduction phenomena, and the evolution equation is derived. Since precise solution of this equation cannot be found, it is solved in a short relaxation time approximation. It is noted that at long relaxation times which may occur in a gas mixture with chemical increments, solitons do not develop in the medium, and perturbations propagate in the form of weak Taylor-type shock waves. In this case relaxation leads to a change in the propagation velocity and an increase in the perturbation dissipation. References 13: 12 Russian, 1 Western.

Free Oscillation of Nonlinear Cubic Two-Degree-of-Freedom System With Close Natural Frequencies

937F0160A Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 57 No 2, Mar-Apr 93 pp 40-49

[Article by Ye.V. Ladygina, A.I. Manevich, Dnepropetrovsk; UDC 539.3:534.1]

[Abstract] Internal resonance in two-degree-of-freedom systems with a nonlinearity in general, and in systems with a cubic nonlinearity and close natural frequencies in particular, is discussed, and the amplitude-frequency modulation equations are derived. Free oscillations in this conservative system with a symmetric characteristic are examined by the method of many scales. The solution of the modulation equations is considered and plotted in the form of characteristic parabolic curves. Various types of curve position are examined, and the steady-state points (corresponding to vibrations without modulation), separatrices, and amplitude-phase portrait are investigated. The effect of the frequency detuning on the behavior of the system is studied, and likely oscillation modulation conditions as a function of the coefficients of the system of differential equations, energy, and initial conditions are analyzed. It is noted that the analyses made for assessing the accuracy of the solution produced by the many scales method demonstrate a virtually total consistency of the analytical and numerical solutions. Moreover, a smaller value of the nondimensional detuning parameter σ^0 does not necessarily correspond to greater modulation. Figures 3; references 8: 4 Russian, 4 Western.

On Cylindrical Precession Stability of Viscoelastic Body Oscillating Along Symmetry Axis

937F0160B Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 57 No 2, Mar-Apr 93 pp 57-66

[Article by Ye.V. Sinitsyn, Moscow; UDC (531.36+629.19):534]

[Abstract] A uniform isotropic dynamically symmetric body moving in a central Newtonian field of forces is considered in a body-axes central system of coordinates with an origin at the center of mass assuming that the center of mass moves along a fixed circular orbit. In particular, a body elongated along the axis of symmetry whose oscillation modes are approximated by the eigenmodes of the longitudinal elastic rod vibrations and whose body material meets the Kelvin-Voight model of the linear theory of viscoelasticity at a constant time-independent Poisson ratio, is examined. A system of equations of motion is derived and solved, and the stability of the partial solution which corresponds to uniform body rotation around the symmetry axis orthogonal to the circular orbit's plane is investigated. The stability condition is examined by reduction in the theory of countable systems of differential equations and Kamenkov's criterion. The conclusion is drawn that such undisturbed motion is asymptotically stable relative to some, but not all, variables. The author is grateful to A.P. Markeyev for interest in the problem and useful discussions. Figures 1; references 15.

On Rigid Body Motion in Particle Flow

937F0160C Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 57 No 2, Mar-Apr 93 pp 77-81

[Article by A.A. Burov, A.V. Karapetyan, Moscow; UDC 531.36]

[Abstract] The study of forces and moments of forces of rigid bodies and media since Newton's pioneering opus is reviewed, and the particular problem of rigid body motion in a flow of gas is considered in a formulation in which the gas consists of identical noninteracting particles flying at a constant velocity in a constant direction in a fixed absolute space, and the particles interact absolutely inelastically with the body, i.e., after the collision, the particle velocity is equal to zero relative to the body. It is noted that although the problem is largely nonconservative, the body's dynamics may, under certain assumptions, be described by the system of Hamilton's equations which makes the issue of the existence of additional first integrals of the equations of motion more interesting. The cases where such integrals exist and steady state motions are suggested, and the motion stability is analyzed. In particular, the centrally symmetric, spherical, axisymmetric, and centrally symmetric plate surfaces of the body interacting with the particle flow have a Hamiltonian structure. References 4: 3 Russian, 1 Western.

Sound Propagation in Liquid Under Elastic Plate With Crack

937F0160D Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 57 No 2, Mar-Apr 93 pp 141-146

[Article by I.V. Andronov, St. Petersburg; UDC (532.5+539.3):534.1]

[Abstract] A vibrating elastic plate with a short rectilinear crack which is in contact with an acoustic medium is considered assuming that the medium is homogeneous and is located only on one side of the plate while the pressure in the medium satisfies Helmholtz's equation. This system's vibrations are excited by a certain unspecified source, and the sound pressure field and the plate displacement field are assumed to be known. The problem of finding the wave process component dissipated by the crack is formulated and reduced to a system of integral equations over an interval. Diffraction in the crack is investigated, and the field asymptotics at a great distance from the crack are considered. To this end, a planar acoustic wave and a planar surface wave are examined. The conclusion is drawn that on the one hand, the acoustic medium leads to the appearance of additional paths around the obstacle thus reducing the effective scattering cross section while on the other, an additional dissipation channel develops for the wave entering the acoustic medium due to the presence of this medium, so the scattering cross section decreases. For shorter cracks, the former phenomenon dominates and leads to the appearance of an additional dissipation channel. References 3.

Reflectance Measurement Adapter for SF-46 Spectrophotometer

937F0164D Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 4, Apr 93 pp 36-37

[Article by N.M. Rostovtsev, V.N. Presnetsov, K.Yu. Frolenkov, Orel Branch of the Information Science Problems Institute at Russia's Academy of Sciences; UDC 537.632]

[Abstract] The need to measure such optical parameters as transmittance and reflectance of thin film coats produced by vacuum deposition, particularly on data discs, prompted the development and production of a special attachment to the popular SF-46 spectrophotometer for measuring the reflectance of these thin film vacuum deposited coats. A schematic diagram of the device is cited, and the dependence of reflectance on wavelength is plotted. The adapter design and operating principle are described, and a formula for calculating the film reflectance is suggested. The device utilizes the fact that within a 0-20° range of angles of incidence, reflectance remains virtually constant and equal to normal reflectance. The results of measured reflectance values obtained by the proposed device are consistent with published data. Figures 3; references 5: 4 Russian, 1 Western.

Precision Capacitive Pressure Gauge

937F0164C Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 4, Apr 93 pp 27-28

[Article by V.A. Rakov, V.G. Timoshenko, Signal Experimental Production Association, Engels; UDC 681.586.33:681.586.772]

[Abstract] The urgency of precision pressure measurements and the stringency of the requirements imposed on the primary data measuring or control element—the sensor which virtually determines the metrological characteristics of the entire system—prompted comparative analyses and tests of more than 40 pressure-to-electric signal conversion methods. The design of a capacitive pressure gauge made with a Fe-Ni-Cr Elinvar alloy, metal and glass junctions, and a balanced compensated bridge capacitive transducer is described and its schematic diagram is cited. The transducer with a variable gap measures the integral value of elastic sensor (UChE) microdeformations which are not practically commensurate with the surface microdeformations resulting from residual stresses in the material, thus contributing to the device's time stability. A microprocessor is used to decrease various error components and the total measurement error. The pressure gauge may serve as the basis for developing unified series of precision absolute pressure gauges which do not call for periodic recalibration during the warranty period. Figures 1; references 4.

Structural Design Methods of Superfast Class of Analog-to-Digital Converters

937F0164B Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 4, Apr 93 pp 22-26

[Article by Yu.A. Khabarov, Scientific Research Institute of Microcomputer Instruments, Zelenograd; UDC 621.3.087.92]

[Abstract] Various types of architecture of parallel and pipelined analog-to-digital converters (ATsP) and these two complementary approaches to superfast ADCs are considered and their relative advantages and shortcomings are compared. Three principal types of structural elements are identified in all ADCs, and the block diagram and timing chart of the parallel and pipelined architecture are cited. The structural methods of increasing the response speed and capacity of superfast converters and the limit of attainable speed and capacity of such converters are examined. The conclusion is drawn that the highest response speed can be reached by using a combined parallel and pipelined "fan" architecture based on the principle of multisequencing or paralleling the processing channels with a time sweep. The speed of such combined architectures is, in the end, determined by the speed of the digital integrated circuits in the control unit; the fastest chips for such ADCs are suggested. The study shows that for Si—based chips, a 500 MHz frequency is the fastest attainable speed for 8-bit ADC and 25 MHz for 9- to 10-bit converters; GaAs makes it possible to raise the speed to 1-2 GHz for 4- to 6-bit ADCs. Figures 6; tables 2; references 30: 20 Russian, 10 Western.

Software and Hardware Complex Development for Computer-Aided Control System With Telemetry and Local Links

937F0164A Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 4, Apr 93 pp 14-18

[Article by A.M. Pshenichnikov, Central Scientific Research Institute of Comprehensive Automation, Moscow; UDC 621.398.004:658.51.011.56]

[Abstract] The outlook for developing the existing software and hardware complex with telemetry and local links (PTK-TLS) is assessed, and the data processing capacity (input and output volume and number of channels) of the new modernized workstations—both low- and high-capacity simple programmable stations without backup (SP-1M and SP-2M) and two-, three-, and four-machine programmable backed-up stations of varying data processing capacity (SPR1-1M, SPR1-2M, SPR1-3M, SPR2-1M, SPR2-2M, SPR3-1M, and UKRS)—are summarized. The advantages of using microcomputers for data processing and display are outlined, and a block diagram of the software and hardware complex with telemetry and local links is cited. The software components, including a distributed database, fast real time operating system, an MS-DOS-based

synchronous process control system, data communication protocols, etc., are described. The software and hardware complex with telemetry and local links can be customized by the developer for all specific applications. The complex is being used in power systems for controlling high-voltage transmission lines, in pipelines, and in the chemical and petrochemical industry. Figures 1; tables 1; references 1.

Principal Characteristics of Modern Locomotive Gimbal Drives With Articulated Quill Couplings

937F0163C Moscow AVTOMATIZATSIYA I SOVREMENNYYE TEKHNOLOGII in Russian No 4, Apr 93 pp 12-15

[Article by Kh.G. Usmanov, I.V. Biryukov; UDC 62-585.862;621.825.6]

[Abstract] The increasing use of gimbal drives with an articulated quill coupling in traction drives of the railroad rolling stock with a frame support suspension of the engine and reduction gear prompted an investigation into the principal characteristics of such locomotive drives. Two types of articulated quill couplings are considered: with the unidirectional and opposing dog positions. A general view and schematic diagrams of a locomotive gimbal drive with both types of dog positions are cited, and the maximum values of the principal drive characteristics and axial forces in the gimbal drive under an axial shaft displacement are summarized. Various types of locomotive gimbal drives are compared; in so doing, the levels of maximum angular dog displacement, the highest radial deformations and attendant elastic forces in the articulated joints, the degree of shaft rotation nonuniformity, and the maximum elastic moments determined by kinematic excitations are taken into account using a unified approach to gimbal drive analysis. The findings make it possible to objectively assess the advantages and shortcomings of various types of drives at the earliest design stage. Figures 3; tables 2; references 4: 2 Russian, 2 Western.

Rotor Balancing During Repairs

937F0163B Moscow AVTOMATIZATSIYA I SOVREMENNYYE TEKHNOLOGII in Russian No 4, Apr 93 pp 6-11

[Article by Yu.A. Samsayev; UDC 621.828.3:62-755]

[Abstract] The discussion of rotor assembly balancing practices which began in *Avtomatizatsiya i sovremennyye tekhnologii* No. 12, 1992 and Nos. 1-3, 1993 continues. Attention is focused on the practices of rotor balancing in electric motors and the difference between rotor balancing during the designing and during the repairs. Several version of efficient practices of balancing the armatures of the TL-2K1 traction motor are considered, and a schematic diagram of the motor's rotor is cited. Block diagrams of efficient traction motor rotor balancing procedures are presented and the advantages and shortcomings of these algorithms are discussed. Although only one particular motor is examined in detail for illustration, the algorithms may be used for other similar products allowing for their specific design versions. It is noted that balancing of mass produced motors during repairs and manufacturing does not pose serious difficulties and had been described in numerous sources. To be continued. Figures 4; references 13.

Shock and Vibration Damping of Electronic-Optical Systems in Video Monitoring Devices

937F0163A Moscow AVTOMATIZATSIYA I SOVREMENNYYE TEKHNOLOGII in Russian No 4, Apr 93 pp 2-6

[Article by M.A. Pavlovskiy, A.V. Shulzhenko; UDC 621.396.6:62-752:629.12.001]

[Abstract] Wide-ranging applications of video monitoring devices on the basis of cathode ray tubes (ELT) with electromagnetic electron beam control as a component of equipment exposed to dynamic factors prompted the development of mechanisms and units which make it possible to maintain a high data display quality and lower the mass, overall dimensions and cost. This necessitated the development of suspension devices for electronic and optical systems (EOS) assembled directly from a CRT and electromagnetic deflection (OS) and focusing (FS) lenses executed as solenoid coils. The design of a shock and vibration damping suspension for electronic-optical devices and its operating principle are described and a block diagram of the system and schematic diagram of the shock absorbing stages are cited. A mathematical model of the shock absorbing system is developed, and the shock absorber layout of the CRT bulb is cited. Technical data on the EOS module are summarized. The shock-damped module is fully interchangeable. Tests of pilot and mass produced prototypes of the mechanical device confirmed the correctness of the design and structural principles used and revealed the possibility of further improving the device's characteristics. The device is protected by 15 patents and is being mass produced. The study gives reason to speculate that the synthesized structural and design arrangements of the device will find wide applications in domestic instrument making and will be competitive in the world market. Figures 5; tables 1; references 3: 2 Russian, 1 Western.

Theory of Quantum One-Ports

937F0161A Kiev AVTOMATIKA in Russian No 1, Jan 93 pp 83-90

[Article by S.A. Smirnov, Scientific and Technical Committee of the Cybernetics Institute imeni V.M. Glushkov at the Ukrainian Academy of Sciences; UDC 681.513:530.145]

[Abstract] The building block miniaturization trend in computer science and engineering and the emergence of nanotechnologies and nanoelectronics call for taking a new look at the quantum patterns of the processes and developing new automatic device operation concepts. To this end, the transfer properties of a special class of artificial quantum systems are examined; the specific features of the class and its motives are defined, and the basic properties and composition rules are considered using a phenomenological approach, i.e., without trying to predict or suggest the specific features of future realizations. The assumption is made that the electron states inside the nanometer-wide atomic strip have only longitudinal (in the sense of wave vector) modes and no transverse modes. The concept of the so-called hypothetical "nanoerector set" or a set of elements for developing data processing devices with nanometer characteristic dimensions is introduced and an attempt is made to identify and examine the principal concepts by abstracting less important elements. The reciprocity theorem is proven, and other properties of quantum two-terminal networks are studied. It is noted that the theory of quantum multiterminal networks developed by the author will be described in a separate publication. The study was financed by the Ukrainian State Committee on Science and Engineering in the framework of state scientific-engineering program 1 (mathematics, mechanics, and information science). Figures 2; references 3.

Special X-Ray Inspection Devices and Computer-Aided Units

937F0179A Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 6, Jun 93 pp 16-24

[Article by V.V. Klyuyev, V.G. Firstov, V.B. Chelnokov, Spektr Interbranch Scientific Production Association, Moscow; UDC 620.179.152]

[Abstract] The design and operating principles of portable X-ray equipment for proximate field inspection and computer-aided systems of low dose inspection of large entities are discussed from the viewpoint of special X-ray inspection tasks, e.g., examination of suspicious objects, parcels, and luggage in order to detect explosives, weapons, and contraband. Both foreign and domestic instruments and systems developed by Astrophysics Research Corp., Philips Electronic Instrum., International Aeradio Ltd., Babteau, Heimann, American Science and Engineering, Scanray Corp., Balteau, etc., are examined. The detection characteristics of X-ray systems, the design and operation of portable X-ray pulsed devices, a set of equipment for proximate radiography on the basis of the diffusion process, and a low dose gas discharge luminescent X-ray image converter are described in detail. Figures 9; tables 3; references 11: 10 Russian, 1 Western.

Range of Reference Facilities for Accelerometer Calibration and Study

937F0179B Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 6, Jun 93 p 38

[Article by V.A. Kryukov, V.A. Soshnikov, Scientific Research Institute of Physical Measurements, Penza; UDC 531.768:389.14]

[Abstract] A range of acceleration reproduction facilities developed at the Scientific Research Institute of Physical Measurements (NIIFI) in Penza for metrological support for the development and manufacture of linear and angular accelerometers is discussed. The complex of devices contains a unit for plotting the static calibration curve (SGKh) and transfer function equipped with devices determining the effect of the ambient temperature on the calibration characteristic; a unit for plotting the dynamic response; and a unit for reproducing angular accelerations. The complex is developed jointly with the Scientific Production Association of the Metrological Scientific Research Institute imeni D.I. Mendeleyev and State Engineering University in St. Petersburg. The characteristics of the components are summarized and their operating principles are described. The developer is offering research assistance. Tables 3.

On Increasing Accuracy of Free Rotor Units for Metrological Certification of Low-Frequency Linear Accelerometers

937F0179C Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 6, Jun 93 pp 39-40

[Article by G.A. Abramchuk, M.N. Ivanov, Minsk; UDC 531.768:681.2.089]

[Abstract] The shortcomings of traditional methods of reproducing linear acceleration (LU) for metrological support for the development and production of low-frequency linear accelerometers, i.e., centrifuges with a fixed spin axis, necessitated the development of calibration units with a free rotor which make it possible greatly to expand the range of reproducible linear acceleration parameters. This prompted attempts to decrease the linear acceleration parameter reproduction errors in the area of high values by taking into account additional terms in the measurement equations both in developing measurement systems and free rotor motion control systems. A mechanical diagram of a test bench with a free rotor is cited and the reproducible motion parameters are plotted. The device contains a rotor system and a two-joint gimbal drive. A block diagram of a computer-aided rotor control system with linear acceleration feedback is presented. The system is capable of ensuring the level of metrological characteristics necessary for calibration; the free rotor system advantages are especially evident in calibration and testing of devices with increased overall dimensions and mass, including navigation systems. Figures 3.

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